HIGH HLB NON-IONIC SURFACTANTS FOR USE AS DEPOSITION CONTROL AGENTS

FIELD OF THE INVENTION

This invention relates to processes for inhibiting and removing contaminants deposited on papermaking parts in papermaking operations, particularly pitch derived from sources of virgin pulp and other contaminants having hydrophobic surfaces.

BACKGROUND OF THE INVENTION

Deposition encountered in papermaking negatively affects paper machine runnability causing frequent downtime from contaminant related machine breaks, frequent unscheduled cleaning, sheet quality problems, slower machine speeds and other problems resulting in lower machine efficiencies and higher costs of manufacture. Historically, papermakers have relied on hazardous solvents, corrosives, and other dangerous materials to alleviate such deposition problems. The use of these chemicals often requires papermakers to stop their machines to boil out machine parts resulting in costly downtime.

Many papermaking processes today employ a mixture of virgin and recycled pulp in sheet formation. The two pulps are processed in separate process stages before eventually being mixed in a machine chest or blend chest, and introduced to the head box. At the head box, the pulp is sprayed onto a wire mesh to form a sheet that is dewatered and removed from the mesh to form finished paper.

The stages in which virgin pulp is processed are typically referred to as the mechanical side of the operation, because the processing of the virgin wood relies upon mechanical shear and strength to break the virgin wood apart into pulp and other components. The process is typically initiated in one or two "refiner" stages wherein the wood is broken down to form a pulp suspension. Pitch dispersants such as naphthalene sulfonate and lignosulfonate are conventionally added at the secondary refiner to keep the pitch that is liberated in the process from depositing onto papermaking parts. After the refiner stages, the pulp suspension is introduced to a high temperature latency chest where alum or other chemicals are typically added to fix the pitch to the fiber. The first latency chest is typically followed by a thickener stage

where water is removed and recycled in the system, followed by another latency chest (typically called the high density chest), bleaching, cleaning and screening stages, and yet another latency chest known as the low density chest, before being mixed with the recycled pulp.

A number of nonionic surfactants are used in papermaking processes as detergents that generally can be characterized as having a midrange hydrophilic/lipophilic balance ("HLB") (*i.e.* between 10 and 14). Other constituents are often applied to the papermaking process that have high HLB values (up to about 18, but these agents typically are added as solubilizers for emulsion polymerization or dispersion applications.

As described by Aston et al. in U.S. Patent No. 4,995,944, one approach to deposit control has been the use of additives directly to the pulp suspension, such as anionic aryl sulfonic acid formaldehyde condensates or cationic dicyandiamide-formaldehyde condensates. These additives may function as sequestrants, dispersants, or surface active agents. The cationic dicyandiamide-formaldehyde aminoplast resins have been described as bringing about the attachment of pitch in the form of discreet particles, to pulp fibers so that the pitch particles are uniformly distributed on the fibers themselves. Consequently, the amount of pitch that accumulates on the papermaking machine is reportedly reduced without causing dark spots or specks of pitch in the paper product.

U.S. Pat. No. 4,184,912 to Payton discloses a method of preventing pitch formation by dispersing and emulsifying pitch particles in the pulp furnish in an exceptionally fine state and uniformly distributing the particles throughout the finished paper. The pitch deposition is controlled by the addition of a three component formulation comprising a non-ionic surfactant plus an anionic surfactant and a low molecular weight anionic polymer. The three component mixture is added to the papermaking pulp system at a point prior to where pitch deposits normally form. Non-ionic surfactants described by the patent include condensation products of higher fatty alcohols with ethylene oxide, such as the reaction product of oleyl alcohol with 10 ethylene oxide units, and condensation products of alkylphenols and ethylene oxide, such as the reaction product of isooctyl phenol with 12 ethylene oxide units.

Several methods in the prior art are directed specifically at controlling the deposition of pitch onto the papermill felt that is used to dewater sheets of paper after they are initially formed. These papermill felts commonly circulate continuously in belt-like fashion between a sheet

contact stage and a return stage. During the sheet contact stage, water is drawn from the sheet usually with the aid of presses and/or vacuum into the pores of the felt. A clean felt, having fine pores that are relatively open, are desirable for effective paper manufacture because this allows more efficient water removal from the paper sheet.

U.S. Pat. No. 4,895,622 to Barnett et al. discloses a press felt conditioning treatment for controlling the deposition of polymerically flocculated particulate substances in a press felt. The treatment includes a combination of a relatively low molecular weight organic polymer in combination with a hydrophilic non-ionic or anionic surfactant such as nonyl phenol ethoxylates having from 9 to 40 degrees of ethoxylation. The treatment is applied by metering the composition in one or more fresh water showers directed onto a press felt between the press nip and the vacuum or uhle box utilized for dewatering the felt.

U.S. Pat. No. 6,517,682 to Hendriks et al. discloses a method of removing sticky materials that have been deposited onto press felt by directly applying to the felt (preferably through one or more fresh water showers) a composition comprising at least one cationic polymer and at least one non-ionic surfactant having an HLB (hydrophilic lipophilic balance) of about 11 to 14.

U.S. Pat. No. 5,520,781 to Curham et al. discloses a process of removing wet strength resins that have been deposited onto press felt by directly applying to the felt a conditioner that contains several ingredients including an ethoxylated nonylphenol having greater than 30 moles of ethoxylation.

Accordingly, there is a need for methods for controlling deposition of contaminants in papermaking processes.

SUMMARY OF INVENTION

The invention meets the foregoing need by providing a method of making paper in a continuous papermaking operation that comprises contacting a first pulp suspension that consists essentially of virgin pulp with a first composition comprising a non-ionic high HLB (hydrophilic lipophilic balance) surfactant and optionally mixing the pulp suspension with a second pulp suspension that comprises recycled pulp, wherein:

i) the pulp suspension comprises a contaminant; and

ii) the surfactant is added in an amount that is sufficient to control deposition of said contaminant onto papermaking parts.

Other embodiments of the invention relate to the use of deposition control compositions that consist essentially of non-ionic high HLB surfactants, and that exclude other deposition control agents. Therefore, in another embodiment the invention provides a method of making paper in a continuous papermaking operation that comprises contacting a pulp suspension with a composition that consists essentially of a non-ionic high HLB surfactant, wherein:

i) said pulp suspension comprises a contaminant; and

ii) said surfactant is added in an amount that is sufficient to control deposition of said contaminant onto papermaking parts.

It has unexpectedly been discovered that non-ionic surfactants that have a high-HLB function in a surprising sequence to (1) retain natural wood pitch and similar contaminants in solution/dispersion during pulp processing, and (2) allow integration of the pitch in the paper sheet that is formed when the pulp is deposited on a wire mesh. A graph is contained in Figure 1 that plots the effect of HLB in non-ionic surfactants on contaminant deposition. The graph illustrates that contaminant deposition dramatically reduces as the HLB of the non-ionic surfactant increases to about 14.0, and that as the HLB increases even further these reductions in contaminant deposition are maintained and improved.

It was particularly surprising that these benefits could be realized from non-ionic high HLB surfactants without adversely affecting other aspects of the papermaking operation. For example, because high HLB non-ionic surfactants are generally very water soluble they are thought to increase water retention in the formed sheet. In addition, non-ionic high HLB surfactants are thought to interfere negatively with other chemical additives to the papermaking system, especially sizing additives. It has unexpectedly been discovered that non-ionic high HLB surfactants can be added to the papermaking system at concentrations below the concentrations at which press felt surfactants and mid-range HLB stock surfactants are typically added or applied, and that these lower concentrations allow the non-ionic high HLB surfactant to be added without interfering with these critical aspects of the papermaking operation.

Traditional treatments for minimizing pitch deposition in virgin mechanical pulp mills usually contain chemistries based upon lignosulfonates, naphthalene sulfonates and other anionic dispersants. These types of dispersants are predominantly anionic in nature, and tend to increase the anionic charge of the virgin mechanical pulp stream. This added anionic charge is not desirable for the papermaker because more alum, cationic coagulants and cationic retention polymers are required to keep the anionic charge minimized for good papermachine retention. In contrast, the nonionic surfactants of the present invention do not add negative charge to the system therefore less alum or cationic polymers are necessary to control cationic demand.

In addition, midrange HLB surfactants contained in the prior art are good wetting agents and negatively affect sizing of the final paper product. These problems are compounded by the quantities of the midrange HLB surfactant that must be added to have a desired effect. In contrast, it has surprisingly been found that the high HLB surfactants of the present invention are not very good wetting agents and can be added at lower dosages than the midrange HLB surfactants of the prior art, and thus do not have a significantly negative affect on paper sizing.

These discoveries have given rise to novel methods for treating pulp suspensions to inhibit pitch and other contaminant deposition onto papermaking parts. These methods can be applied generally to all facets of the papermaking process, but are particularly applicable to the treatment of virgin wood pulp suspensions in which pitch is often the predominant contaminant. It has been discovered that the surfactant stabilizes the mostly hydrophobic surface of the pitch and renders it practically unable to deposit onto papermaking parts, especially plastic papermaking parts that have an affinity for such contaminants. Because of its mechanism of action, the non-ionic high HLB surfactants can be used to control the deposition of practically any contaminant that has a mostly hydrophobic surface.

The methods of the present invention are preferably practiced in a pinpoint fashion, by introducing compositions that consist essentially of a non-ionic high HLB control agent to the papermaking system precisely at the point in the papermaking operation where the control of pitch deposition is most needed. The non-ionic high HLB surfactants can thus be added to multiple points in the virgin pulp processing section (i.e. the mechanical side of the process), such as before, during or after the secondary refiner stage, the latency chest stage, the thickener stage, the high density chest stage, the bleaching and cleaning stages, the low density chest stage,

and/or the machine chest stage. Alternatively, the high HLB surfactants can be added to mixed processing streams (*i.e.* virgin pulp and recycled pulp mixed streams), or to process streams that have previously been chemically treated, at various stages, such as before, during, or after the machine chest or head box, or directly to press felt through a showering mechanism. The non-ionic high HLB surfactants control contaminant deposition immediately at the point of addition, as well as in subsequent stages such as at the press felt conditioning stage.

In addition, because the compositions preferably consist essentially of high HLB surfactants that are specific for pitch and other contaminants with largely hydrophobic surfaces, it is possible to pinpoint pitch deposition problems on papermaking parts without the addition of other deposition control agents that could adversely affect the papermaking process.

DESCRIPTION OF THE FIGURES

Figure 1 is a graphical correlation of contaminant deposition in a system in which deposition is controlled by nonylphenol ethoxylates, showing the decrease in deposited contaminant weight as the HLB of the nonylphenol ethoxylates is progressively increased.

Figure 2 is a graphical correlation of contaminant deposition in a system in which deposition is controlled by linear alcohol ethoxylates, showing the decrease in deposited contaminant weight as the HLB of the linear alcohol ethoxylates is progressively increased.

Figure 3 is a graphical correlation of contaminant deposition in a system in which deposition is controlled by tridecyl alcohol ethoxylates, showing the decrease in deposited contaminant weight as the HLB of the tridecyl alcohol ethoxylates is progressively increased.

Figure 4 is a graphical correlation of contaminant deposition in a system in which deposition is controlled by EO-PO block copolymer derivatives, showing the decrease in deposited contaminant weight as the HLB of the EO-PO block copolymer derivatives is progressively increased.

DETAILED DESCRIPTION

Definitions

The term alkyl, as used herein, unless otherwise specified, includes saturated straight, branched, or cyclic, primary, secondary, or tertiary hydrocarbon, *e.g.* C_1 to C_{16} or C_1 to C_{12} or C_1 to C_6, specifically includes methyl, ethyl, propyl, isopropyl, butyl, isobutyl, *t*-butyl, pentyl,

cyclopentyl, isopentyl, neopentyl, hexyl, isohexyl, cyclohexyl, cyclohexylmethyl, 3-methylpentyl, 2,2-dimethylbutyl, and 2,3-dimethylbutyl. The alkyl group can be optionally substituted with one or more moieties selected from the group consisting of hydroxyl, carboxy, carboxamido, carboalkoxy, acyl, amino, alkylamino, arylamino, alkoxy, aryloxy, nitro, cyano, sulfonic acid, sulfate, phophonic acid, phosphate, or phosphonate, either unprotected, or protected as necessary, as known to those skilled in the art, for example, as taught in *Greene, et al.*, "Protective Groups in Organic Synthesis," John Wiley and Sons, Second Edition, 1991, hereby incorporated by reference.

The term lower alkyl, as used herein, and unless otherwise specified, refers to a C_1 to C_5 saturated straight, branched, or if appropriate, a cyclic (for example, cyclopropyl) alkyl group. The lower alkyl group can be optionally substituted in the same manner as described above for the alkyl group.

The term "HLB," as used herein, refers to the "hydrophilic-lipophilic balance" of a molecule. The HLB number indicates the polarity of the molecules in an arbitrary range of 1-40, with the most commonly used emulsifiers having a value between 1 and 20. The HLB number increases with increasing hydrophilicity. The HLB system is a semi-empirical method to predict what type of surfactant properties a molecular structure will provide. The HLB system is based on the concept that some molecules have hydrophilic groups, other molecules have lipophilic groups, and some have both. The HLB of a surfactant can be calculated according to Griffin WC: "Classification of Surface-Active Agents by 'HLB,'" *Journal of the Society of Cosmetic Chemists* 1 (1949): 311; and Griffin WC: "Calculation of HLB Values of Non-Ionic Surfactants," *Journal of the Society of Cosmetic Chemists* 5 (1954): 259.

The term "high HLB surfactant," as used herein, means a surfactant having a HLB that is sufficiently high to materially disperse and/or solubilize pitch of its own accord.

Wet strength resins – The term "wet strength resins" refers to those resins added to a pulp suspension to give the paper product that is eventually formed strength when it becomes wet. Wet strength resins are thus often used when making tissues, napkins and paper towels. Wet strength resins include, for example, polyaminoamide epichlorohydrins, ureaformaldehyde, melamine formaldehyde, and polyacrylamide, and typically deliver a cationic charge to the paper stock flow.

Pulp suspension – The term pulp suspension refers to practically any suspension of pulp fiber in the papermaking operation before the suspension is laid down on a wire mesh to form the paper sheet. Grades of pulp suspensions include mechanically generated, semi-chemically generated, chemical thermo mechanical pulp, Kraft pulp, and grades generated by other processes such as the well-known sulfite and ozonation processes.

Description of Various Embodiments

It has been found that contaminant deposition can be controlled by stabilizing the hydrophobic surface of various contaminants, especially pitch in pulp suspensions that are derived principally (if not exclusively) from virgin pulp, and that non-ionic high HLB surfactants have such stabilizing capacity. The non-ionic high HLB surfactants can be used in various ways to control contaminant deposition, but are particularly useful when added as stock additives to pulp suspensions because they can solubilize and/or disperse such contaminants before they are ever even deposited onto papermaking parts.

It is well known that pitch has favorite places for accumulating on the various apparatus and equipment associated with the processing of pulp. The compositions of the invention can be added to a point in the mill system ahead of these so-called problem areas. In certain instances, the compositions may be added at multiple locations throughout the system to ensure prevention of pitch buildup at several locations throughout the wet end of the papermaking process. Preferred locations for adding the non-ionic high HLB surfactants of the present invention include the so-called "mechanical side" of the papermaking operation in which virgin pulp is processed. The non-ionic high HLB surfactant can be added on the mechanical side of the operation before, during, or after the secondary refiner stage, the latency chest stage, the thickener stage, the high density chest stage, the bleaching and cleaning stages, the low density chest stage, and/or the machine chest stage.

The high-HLB surfactants of the present invention solubilize and/or disperse pitch present in these pulp suspensions throughout the various pulp processing stages, and continuing through the press felt conditioning stage, even after the pulp leaves the mechanical side of the operation and the virgin pulp is mixed with a second pulp suspension that comprises recycled pulp. Therefore, in a first principal embodiment the invention provides a method of making paper in a continuous papermaking operation comprising:

a) contacting a first pulp suspension that consists essentially of virgin pulp with a first composition comprising a non-ionic high HLB surfactant, wherein:

    i) said pulp suspension comprises a contaminant; and

    ii) said surfactant is added in an amount that is sufficient to inhibit deposition of said contaminant onto papermaking parts; and

b) optionally mixing said first pulp suspension with a second pulp suspension that comprises recycled pulp (such as from mixed office waste or recycled newsprint).

Alternatively (or in addition), the surfactant is added to a pulp slurry that comprises recycled pulp and virgin pulp, especially pulp slurries that comprise virgin pulp and pulp derived from recycled newsprint. The proportions of virgin pulp to recycled pulp can range, e.g., from about 40:60 to about 95:5, from about 50:50 to about 90:10, or from about 60:40 to about 80:20.

The term "amount that is sufficient to control deposition" of said contaminant, as that term is used herein, refers to an amount that reduces deposition of the contaminant, for example by about 35%, 50%, 65%, 75%, or 85%, in comparison to a method in which paper is made in the absence of the contaminant. The reduction may occur in various papermaking parts, especially in the mechanical side of the operation in equipment such as the first or second refiner stage, a high temperature latency chest, a thickener stage, another latency chest (typically called the high density chest), bleaching, cleaning and screening stages, and or the low density chest.

While the methods of the present invention are most particularly applicable to the control of pitch deposits in the papermaking operation, it will be understood that the invention can be practiced to control the deposit of practically any contaminant that has a mostly hydrophobic surface that can be stabilized by the high-HLB surfactant. Thus, for example, the invention can be practiced with various types of pitch (i.e. wood resins, fatty esters, fatty acids, fatty acid salts and other natural components), latex (e.g. SBR and PVAc), hot melt and pressure sensitive adhesives (e.g., EVAc, polyamides and polyurethanes), waxes, oils, ink, sizes, starch, defoamer components (e.g. EBS and silicone) and other contaminants. In addition, while the invention is particularly aimed at solubilizing/dispersing contaminants that are already present in a pulp slurry, it will be understood that the term "controlling" contaminant deposition includes the removal of contaminants that have already been deposited onto papermaking parts.

In various embodiments, the HLB of the non-ionic surfactant exceeds about 12, 12.5, 13, 13.5, 14, 14.2, 14.5, 15, 15.5, or 16, and/or is less than about 30, 25, 20, 19.5, 19, 18.5, 18.1, 18, 17.5, or 17. The HLB preferably ranges from about 12.0 to about 20.0, from about 14.2 to about 20.0, or from about 14.0 to about 18.1. Preferred high HLB surfactants are represented by compounds of the structure $R\text{-}O\text{-}(CH_2CH_2O)_x\text{-}H$, wherein R is the residue of a $C_{2\text{-}12}$ alkyl phenol (preferably C_6-C_{12}) (ortho, meta, or para) or a $C_{2\text{-}16}$ (preferably $C_{10\text{-}15}$) linear or branched alcohol, and x is an integer of from about 12 to about 40. Octyl and nonyl phenols, and dodecyl and tridecyl alcohols, are preferred precursors to the R residue. The x integer preferably represents from about 14, 15, 16, 17, 18, 19, 20, 21 or 22 to about 40 moles of ethoxylation. Notably, the ethoxyl chain can be substituted by up to about 1-5 % propoxyl moieties, as block or random substitutions, without affecting the properties of the molecule.

Another type of preferred high HLB surfactant are the ethoxylated polyoxypropylene glycols represented by the following chemical structure: $HO\text{-}(CH_2CH_2O)_x\text{-}(CH(CH_3)CH_2O)_y(CH_2CH_2O)_{x'}\text{-}H$, wherein x+x' is an integer of from about 52 to about 200, more particularly from about 125 to about 200, and y is an integer of from about 39 to about 68, more particularly from about 39 to about 55. Other high HLB surfactants useful in the practices of this invention also include propoxylated polyethylene glycols, ethoxylated fatty acids, ethoxylated castor oil, alkyl polyglycosides, and polyoxyethylene sorbitan monooleates. These surfactants are preferably all approved by the Food and Drug Administration and suitable for making food packaging materials.

Other embodiments of the invention relate to the use of deposition control compositions that consist essentially of non-ionic high HLB surfactants that exclude other deposition control agents. The non-ionic high HLB surfactant is typically prepared as a water/surfactant solution, and preferably omits other agents such as lignosulphonates, naphthalene sulfonates, polyacrylates, di-isobutylene maleic anhydride copolymers, polyvinyl alcohol and organic acids including citric acid and lactic acid. Therefore, in another embodiment the invention provides a method of making paper in a continuous papermaking operation that comprises contacting a first pulp suspension with a first composition that consists essentially of a non-ionic high HLB surfactant, wherein:

a) said pulp suspension comprises a contaminant; and

b) said surfactant is added in an amount that is sufficient to control deposition of said contaminant onto papermaking parts.

Still other embodiments are characterized by the absolute HLB value of the non-ionic high HLB surfactant used in the system. Thus, in still another embodiment the invention provides a method of making paper in a continuous papermaking operation comprising contacting a pulp suspension in said papermaking operation with a first composition, wherein:

a) said first composition comprises a non-ionic surfactant having a HLB of greater than 14.2;

b) said pulp suspension comprises a contaminant; and

c) said surfactant is added in an amount that is sufficient to inhibit deposition of said contaminant onto papermaking parts.

The pulp suspensions to which the high-HLB surfactants are added are typically anionically charged, and it is therefore useful to avoid increasing the cationic demand of the system. Therefore, it is also often preferred that the surfactant be added to the system in a composition that excludes any anionic agents, especially any anionic dispersants such as those employed in the prior art.

The invention is not limited to the addition of high HLB surfactants to pulp suspensions in the wet side of the papermaking operation, and includes the addition of high HLB surfactants to any phase or stage of the papermaking operation in which pitch deposits are a problem. For example, the high HLB surfactants of the present invention can be applied directly the press felt or rollers in a press felt conditioning stage to control the deposition of pitch onto the press felt or rollers. In such applications, the deposits onto the papermaking parts are controlled by inhibiting the deposits, removing the deposits, or both. Therefore, in another embodiment the invention provides a method of making paper in a continuous papermaking operation from a pulp suspension comprising:

a) providing a continuous papermaking operation that comprises a press felt conditioning stage, wherein:

   i) the operation is experiencing excessive contaminant deposition in the press felt conditioning stage; and

ii) said press felt conditioning stage comprises a showering unit for applying conditioning chemicals to said press felt;

b) adding to said showering unit a composition consisting essentially of a non-ionic high HLB surfactant.

Still another embodiment relies upon the ability of non-ionic high-HLB surfactants to selectively control pitch deposition in papermaking operations, and the users' ability to substitute one non-ionic high-HLB surfactant for another in a papermaking operation. Therefore, the invention also provides a method of making paper in a continuous papermaking operation from a pulp suspension comprising:

a) providing a continuous papermaking operation in which parts are contacted by a first decontaminating composition that comprises a high HLB surfactant, wherein the operation experiences excessive pitch deposition in the absence of the first decontaminating composition; and

b) substituting a second decontaminating composition comprising a high HLB surfactant for said first decontaminating composition.

While high HLB surfactants have historically been shunned by the papermaking industry because of deleterious effects they can have on the paper making system, it has surprisingly been found that the methods of the present invention can be practiced with concentrations of surfactants that are too low to have such effects. Thus, for example, the concentration of high-HLB surfactant added to the system is preferably insufficient to adversely affect the sizing of paper sheet produced from the pulp suspension. Similarly, the concentration of high-HLB surfactant is preferably insufficient to materially increase the water retention of paper sheet produced from said pulp suspension.

When added to the pulp suspensions, the surfactant is preferably added to give a concentration of from about 0.5 pounds to about 10 pounds weight parts surfactant per ton based on dried pulp within the pulp suspension, more preferably from about 2 pounds to about 5 pounds weight parts surfactant per ton based on dried pulp within the pulp suspension. When applied directly to papermaking parts, the surfactant is preferably applied at a rate of from about 50 to about 1200 ppm and more preferably from about 150-900 ppm based on total shower flow.

The invention is particularly effective to control contaminant deposition onto paper machine parts such as rolls, calendar stacks, and dryer cans, and is especially useful to control deposition onto plastic surfaces such as headbox components, wires, foil blades, press felts, dryer fabrics, uhle box covers, and sensor heads. The methods are particularly suitable for controlling the deposition of contaminants onto press felts that are made from nylon belts.

The methods of the present invention can be practiced in systems in which other deposition control agents are either present or absent. Such deposition control agents include, for example, sequestrants, dispersing agents, organic solvents (such as aromatic hydrocarbons) and surface active agents. For example, the compositions of the present invention can be used to replace conventional chemicals for dispersing pitch such as naphthalene sulfonate and lignosulfonate.

The methods of the invention are preferably practiced in systems that produce paper from pulp suspensions that include virgin pulp. The content of virgin pulp in the formed sheet of paper is preferably greater then 1 wt.%, 10 wt.%, 35 wt.%, 60 wt.%, or 90 wt.%, and up to 100 wt.%.

Similarly, the high HLB surfactants of the present invention can be added in compositions that contain other deposition control agents, or that consist essentially of the high HLB surfactant. The high HLB surfactant is preferably added in a composition that contains only the high HLB surfactant, however, because it allows the surfactant to be more precisely targeted at the contaminants that are controllable via the methods of the present invention, on an as-needed basis. Thus, for example, in virgin pulp suspensions wherein pitch is the primary contaminant deposited on paper making parts, the virgin pulp may be processed in the substantial absence of a second control agent until the virgin pulp stream is mixed with a pulp recycle stream that presents its own unique set of deposition control issues. Similarly, in a preferred embodiment, the present invention is practiced substantially in the absence of one or more of said wet-strength resins.

EXAMPLES

Test Method and Examples

The following test method and examples demonstrate the unexpected superior efficacy of the invention over the prior art. A proprietary test method using mill stock from different areas of the paper making process was utilized to evaluate the performance of nonionic surfactant treatments with various HLBs. The test involves mixing the pulp suspension at an appropriate consistency to produce deposition on a plastic coated paddle. The stock is mixed with a plastic coated paddle at constant speed and under control temperatures to simulate the deposition that occurs on paper machine parts, especially on plastic parts. The deposition is then quantified by extracting the pitch and other contaminants with a volatile solvent to measure the weight of deposition after the solvent evaporates. A lower weight of deposition on the plastic paddle surfaces indicates better performance. Because the method measures relative deposition potential of the pulp suspensions it has been successfully utilized to commercialize technology that is not covered in this patent application. Treatments that inhibit deposition on machine surfaces often enhance the runnability of the paper making process and improve the quality of the final paper product.

Nonionic surfactant samples were obtained from various chemical manufactures. HLB, and moles of ethoxylation (EO) and propoxylation (PO) for the samples tested were listed in technical bulletins supplied by the various nonionic surfactant manufactures.

Example I

Following is a table reporting the efficacy results from a series of tests performed on a pulp suspension obtained from a mill using 100% virgin mechanically pulped wood fiber. The unexpected superior efficacy of the high HLB surfactants is evident based on the relatively low amount of deposition remaining on the paddle after treatment with these chemistries. A pulp suspension from a 100% virgin mechanically pulped fiber source was used for the primary screening of the nonionic surfactants because these types of papermaking operations contain the most troublesome pitch contaminants. The results in the table demonstrate the efficacy of the high HLB surfactants with various fatty alcohol hydrophobes including nonylphenol, C10-C16 linear alcohols, tridecyl alcohol and polypropylene glycol (PO).

TABLE I

Nonionic Surfactant Efficacy Testing in 100% Virgin Mechanical Pulp

Untreated Controls		
Treatment	Dosage (lbs/ton)	Contaminant Weight (g)
Untreated Control	0	0.1086
Untreated Control	0	0.0939
Untreated Control	0	0.0924
Untreated Control	0	0.0882
Untreated Control	0	0.0967
Nonylphenol Ethoxylates		
Treatment HLB/moles EO	Dosage (lbs/ton)	Contaminant Weight (g)
9.3	5	0.1673
10.3	5	0.1597
13.2/9	5	0.0700
14.2/12	5	0.0382
15.1/15	5	0.0325
18.1/40	5	0.0246
13.2/9	2	0.0724
14.2/12	2	0.0581
15.1/15	2	0.0457
18.1/40	2	0.0331
C_{10}-C_{16} Linear Alcohol Ethoxylates		
Treatment HLB/moles EO	Dosage (lbs/ton)	Contaminant Weight (g)
9.5/	3	0.1523
12.0/7	3	0.1307
14.4/12	3	0.0382
18.2/40	3	0.0247
Tridecyl Alcohol Ethoxylates		
Treatment HLB/moles EO	Dosage (lbs/ton)	Contaminant Weight (g)
7.8	3	0.0821
10.9	3	0.0705
12.5	3	0.0549
15.0	3	0.0318

18.0	3	0.0312
EO-PO Block Copolymers		
Treatment HLB/moles PO/moles EO	Dosage (lbs/ton)	Contaminant Weight (g)
8.7/68/39	3	0.0821
12.1/39/52	3	0.0415
15.3/64/200	3	0.0212

The foregoing test results are graphically plotted in Figures 1-4 herein.

Example 2

A similar mixer test series was performed using a pulp suspension from a mill using approximately 65% virgin mechanically pulped furnish and 35% deinked furnish. The aforementioned furnish contained contaminant components comprised of pitch, stickies, ink and other recycled materials. Resulting paddles from the mixer testing did not result in contamination that could be quantified using solvent extraction so a proprietary image analysis (IA) technique was used to estimate the contamination of the plastic surface of the paddles. The measurement is purely relative and the lower the contaminant volume as estimated by IA on the paddle surface then the greater the product efficacy.

The results of the testing are listed in the following table. The following table of results demonstrates the better efficacy of the high HLB surfactants versus the prior art in a system containing contaminants from both virgin and recycled furnishes. Only the nonylphenol ethoxylate with an HLB of 18.1 did not perform better than some of the lower HLB surfactants tested, however the higher HLB linear alcohol and tridecyl alcohol ethoxylates did perform better than the lower HLB surfactants with the same starting fatty alcohol phydrophobes.

TABLE II

Nonionic Surfactant Efficacy Testing in 65% Virgin Mechanical and 35% Recycled Pulp

Untreated Controls		
Treatment	Dosage (lbs/ton)	Contaminant Volume (IA)
Untreated Control	0	43494

Untreated Control	0	52407
Untreated Control	0	35835
Nonylphenol Ethoxylates		
Treatment HLB	Dosage (lbs/ton)	
9.3	2	210348
10.3	2	169695
13.2	2	4102
14.2	2	3634
15.1	2	389
18.1	2	6128
C_{10}-C_{16} Linear Alcohol Ethoxylates		
Treatment HLB	Dosage (lbs/ton)	Contaminant Volume (IA)
9.5	1	98013
12.0	1	43011
14.4	1	6411
18.2	1	165
Tridecyl Alcohol Ethoxylates		
Treatment HLB	Dosage (lbs/ton)	Contaminant Volume (IA)
7.8	1	103975
10.9	1	87727
12.5	1	15381
15.0	1	132
18.0	1	66

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and accordingly reference should be made to the appended claims rather than the foregoing specifications as indicating the scope of the invention.